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*Subsurface Exploration, Geologic Hazard, and
Geotechnical Engineering Report*

EAGLEMONT PHASES 4, 5, 6, 7, AND 8
Monroe, Washington

Prepared For:
SELECT HOMES, INC.

Project No. KE120280A
December 11, 2014
Revised April 29, 2015

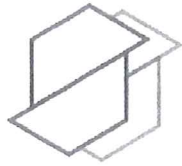
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CITY OF MONROE



Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, WA 98033
P (425) 827 7701
F (425) 827 5424



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December 11, 2014
Revised April 29, 2015
Project No. KE120280A

Select Homes, Inc.
16531 13th Avenue West, Suite A-107
Lynnwood, Washington 98037

Attention: Mr. Craig Pierce

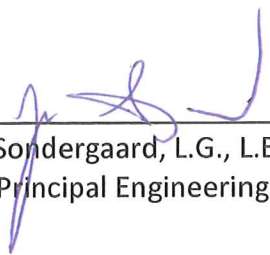
Subject: Subsurface Exploration, Geologic Hazard, and
 Geotechnical Engineering Report
 Eaglemont Phases 4, 5, 6, 7, and 8
 Monroe, Washington

Dear Mr. Pierce:

We are pleased to present the enclosed copies of the above-referenced report. This report summarizes the results of our subsurface exploration, geologic hazard, and geotechnical engineering studies and offers recommendations for the preliminary design and development of the proposed project. Our recommendations are preliminary in that construction details have not been finalized at the time of this report.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington



Jon N. Sondergaard, L.G., L.E.G.
Senior Principal Engineering Geologist

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**SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND
GEOTECHNICAL ENGINEERING REPORT**

EAGLEMONT PHASES 4, 5, 6, 7, AND 8

Monroe, Washington

Prepared for:

Select Homes, Inc.

16531 13th Avenue West, Suite A-107
Lynnwood, Washington 98037

Prepared by:

Associated Earth Sciences, Inc.

911 5th Avenue
Kirkland, Washington 98033
425-827-7701
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I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of Associated Earth Sciences, Inc.'s (AESI's) subsurface exploration, geologic hazard, and geotechnical engineering study for Eaglemont Phases 4, 5, 6, 7 and 8 located west of Eaglemont Phases 2 and 3, east of 191st Avenue SE, and north and east of 136th Street SE in Monroe, Washington (Figure 1). The site boundaries and the approximate locations of the explorations accomplished for this study are presented on the "Site and Exploration Plan," Figure 2.

The recommendations in this report are considered to be preliminary because construction details were not finalized at the time of this study. Once development plans are substantially complete, the conclusions and recommendations in this report should be reviewed and modified, or verified, as appropriate.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data to be used in the preliminary design and development of the subject project. Our study included a review of available geologic literature, excavating seven exploration pits, and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow ground water conditions. Geotechnical engineering studies were also conducted to assess the type of suitable foundation, allowable foundation soil bearing pressures, temporary cut slope recommendations, anticipated settlements, basement/retaining wall lateral pressures, floor support recommendations, and drainage recommendations. This report summarizes our current fieldwork and offers development recommendations based on our present understanding of the project.

1.2 Authorization

Authorization to proceed with this study was granted by Mr. Craig Pierce of Select Homes, Inc. Our study was accomplished in general accordance with verbal discussions with Mr. Pierce. This report has been prepared for the exclusive use of Select Homes, Inc., and their agents, for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

2.1 Site and Project Description

The subject site consists of an irregular-shaped property comprised of seven tax parcels and portions of another covering approximately 25 acres. The property extends from the west end of Eaglemont Phases 2 and 3, east to 191st Avenue SE, north and east of 136th Street SE, and is located south of 130th Place SE and Chain Lake Road in Monroe, Washington. The location of the subject site is shown on the "Vicinity Map," Figure 1 and Site and Exploration Plan, Figure 2. The property is developed with scattered residential homes and outbuildings and is vegetated by mixed coniferous/deciduous forest with thick natural brush. The northern portion of the property is relatively flat-lying, but becomes gently to moderately sloping down toward the south in the southern portion of the site. Review of topographic contours shown on the attached "Site and Exploration Plan" indicates that slope inclinations in the southern portion of the site range from approximately 5 to 15 percent.

It is our understanding that project plans include subdividing the property into residential parcels and constructing single-family homes on the lots with associated roads and utilities.

3.0 SUBSURFACE EXPLORATION

Our field study included excavating a series of seven exploration pits to gain subsurface information about the site. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in the Appendix. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. Our explorations were approximately located in the field relative to known site features shown on the attached site plan.

The conclusions and recommendations presented in this report are based, in part, on the exploration pits completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. Due to the random nature of deposition and the alteration of topography by past grading and/or filling, subsurface conditions may vary outside of the areas of the explorations. The nature and extent of any variations between the field explorations may not become fully evident until construction. If variations in subsurface conditions are observed at the time of construction, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Pits

Exploration pits were excavated with a small track-mounted excavator. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by an engineering geologist from our firm. Selected samples were then transported to our laboratory for further visual classification and testing, as necessary.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the explorations completed for this study, our visual reconnaissance of the site, and review of applicable geologic literature. As shown on the exploration logs, the exploration pits generally encountered silty sand with gravel. The following section presents more detailed subsurface information organized from the shallowest (youngest) to the deepest (oldest) sediment types.

4.1 Stratigraphy

Topsoil

An organic topsoil layer capped with either sod or forest duff was encountered at each of the exploration locations. The topsoil layer ranged in thickness from approximately 6 to 12 inches. Because of its relatively loose condition and high organic content, the topsoil is not considered suitable for foundation support or for use in a structural fill.

Vashon Lodgement Till

Sediments encountered directly below the topsoil layer at each of the exploration pit locations generally consisted of an unsorted mixture of loose to medium dense, reddish brown to tan, silty sand with gravel and scattered cobbles and boulders. Below depths ranging from approximately 3 feet, these sediments became dense to very dense and grayish tan. We interpret these sediments to be representative of Vashon lodgement till. The Vashon lodgement till consists of an unsorted mixture of silt, sand, and gravel that was deposited directly from basal, debris-laden glacial ice during the Vashon Stade of the Fraser Glaciation, approximately 12,500 to 15,000 years ago. The high relative density characteristic of the lodgement till is due to its consolidation by the massive weight of ice from which it was deposited. The reduced density and reddish brown to tan coloration observed in the upper portion of the till is interpreted to be due to weathering. At the locations of our explorations, the Vashon till extended beyond the maximum depths explored of approximately 4½ to 10 feet.

Review of the regional geologic map of the area titled *Geologic Map of the Skykomish River 30-by 60-Minute Quadrangle, Washington*, compiled by Tabor, Frizzell, Booth, Waitt, Whetten, and Zartman (1993) indicates that the area of the project site is underlain by Vashon lodgement till. Our interpretation of the sediments encountered in our explorations is in agreement with the regional geologic map.

4.2 Hydrology

Thin zones of slow, perched, ground water seepage were encountered within the till at the locations of exploration pits EP-102 through EP-107 at depths of approximately 2½ to 3 feet at the base of the weathered till horizon. The seepage represents a “perched” water table which forms during wet periods of the year atop the unweathered till. Perched water occurs when surface water infiltrates down through relatively permeable soils (weathered till) and becomes trapped or “perched” atop a comparatively impermeable barrier such as the unweathered till. This water may travel as interflow and typically will follow the ground surface topography. The duration and quantity of interflow seepage will largely depend on the soil grain-size distribution, topography, and seasonal precipitation.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and shallow ground water conditions as observed and discussed herein and our review of the *City of Monroe Municipal Code* (MMC) for Critical Areas Title 20.05.

5.0 SEISMIC HAZARDS AND MITIGATIONS

Earthquakes occur in the Puget Lowland with great regularity. The vast majority of these events are small and are usually not felt by people. However, large earthquakes do occur, as evidenced by the 1949, 7.2-magnitude event; the 2001, 6.8-magnitude event; and the 1965, 6.5-magnitude event. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely in the Puget Sound area every 20 to 40 years.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides, 3) liquefaction, and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below. In our opinion, the site is not a seismic hazard area according to MMC 20.05.

5.1 Surficial Ground Rupture

The nearest known fault traces to the project site are the South Whidbey Island Fault Zone (SWIFZ), located approximately 13 miles southwest of the site, and the Seattle Fault Zone, located approximately 19 miles to the south.

A 2005 study by the U.S. Geological Survey (USGS) (Sherrod et al., 2005, *Holocene Fault Scarps and Shallow Magnetic Anomalies Along the Southern Whidbey Island Fault Zone near Woodinville, Washington*, Open-File Report 2005-1136, March 2005) reported that “strong” evidence of prehistoric earthquake activity has been observed along two fault strands thought to be part of the southeastward extension of the SWIFZ. The study suggests as many as nine earthquake events along the SWIFZ may have occurred within the last 16,400 years. The recognition of this fault splay is relatively new, and data pertaining to it are limited with the studies still ongoing. The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of one thousand years.

Studies of the Seattle Fault Zone by the USGS (e.g., Johnson et al., 1994, *Origin and Evolution of the Seattle Fault and Seattle Basin, Washington*, Geology, v. 22, pp. 71-74; and Johnson et al., 1999, *Active Tectonics of the Seattle Fault and Central Puget Sound Washington - Implications for Earthquake Hazards*, Geological Society of America Bulletin, July 1999, v. 111, n. 7, pp. 1042-1053) have provided evidence of surficial ground rupture along a northern splay of the Seattle Fault. According to the USGS studies, the latest movement of this fault was about 1,100 years ago when about 20 feet of surficial displacement took place. This displacement can presently be seen in the form of raised, wave-cut beach terraces along Alki Point in West Seattle and Restoration Point at the south end of Bainbridge Island. The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of several thousand years.

Due to the suspected long recurrence intervals for both fault zones, the potential for surficial ground rupture is considered to be low during the expected life of the proposed structures.

5.2 Seismically Induced Landslides

It is our opinion that the risk of damage to the proposed structures by landsliding under both static and seismic conditions is low due to the lack of steep slopes on the subject site and adjoining areas. No mitigation of landslide hazards is warranted. In our opinion, the site is not a landslide hazard area according to MMC 20.05.

5.3 Liquefaction

It is our opinion that the sediments underlying the site present a low risk of liquefaction due their dense state and the lack of adverse ground water conditions. No mitigation of liquefaction hazards is warranted.

5.4 Ground Motion

Based on the encountered stratigraphy, visual reconnaissance of the site, and the analyses conducted for this study, it is our opinion that any earthquake damage to the proposed structures when founded on suitable bearing strata in accordance with the recommendations presented in this report would likely be caused by the intensity and acceleration associated with the event and not any of the above-discussed impacts.

Structural design of the project should be in accordance with the 2012 *International Building Code* (IBC) using Site Class "C".

6.0 EROSION HAZARDS AND MITIGATIONS

The natural glacial sediments underlying the site generally contain a high percentage of silt and fine sand and are sensitive to erosion; however, the potential for erosion at the site is moderated by the fairly flat topography. In order to control erosion and reduce the amount of sediment transport off the site during construction, the following recommendations should be followed.

1. Properly embedded silt fencing should be placed around the lower perimeter of the cleared area(s). The fencing should be periodically inspected and maintained, as necessary, to ensure proper function.
2. The construction entrance should be stabilized with gravel pads to minimize tracking sediment off-site.
3. If possible, construction should proceed during the drier periods of the year.
4. Areas stripped of vegetation during construction should be mulched and hydroseeded, replanted as soon as possible, or otherwise protected. During winter construction, hydroseeded areas should be covered with clear plastic to facilitate grass growth.
5. If excavated soils are to be stockpiled on the site for reuse, measures should be taken to reduce the potential for erosion from the stockpile. These could include, but are not limited to, limiting stockpiled soil to the flatter areas of the site, covering stockpiles with plastic sheeting, and the use of straw bales/silt fences around pile perimeters.

Review of the U.S. Department of Agriculture Natural Resources Conservation Service (formerly known as the Soil Conservation Service) soil survey for the subject area, indicates that mapped soil types for the site include Tokul gravelly loam, 0 to 8 percent slopes, and Tokul gravelly loam, 8 to 15 percent slopes. The mapped soil types are consistent with the sediments encountered in our explorations. Given presence of this soil type, the site does not classify as an erosion hazard area under MMC 20.05

III. PRELIMINARY DESIGN RECOMMENDATIONS

7.0 INTRODUCTION

Our exploration indicates that, from a geotechnical standpoint, the parcel is suitable for the proposed development provided the recommendations contained herein are properly followed. The foundation bearing stratum is relatively shallow and conventional spread footing foundations may be utilized. Consequently, foundations bearing on either the medium dense to very dense, natural glacial sediments or on structural fill placed over these sediments are capable of providing suitable building support.

8.0 SITE PREPARATION

8.1 Clearing and Stripping

Following demolition of the existing structures, any underground utilities located within the proposed building areas should be removed or relocated. The resulting depressions should be backfilled with structural fill as discussed under the "Structural Fill" section of this report. Any remaining foundation elements that will not be incorporated into the new buildings should also be removed. Site preparation of the planned building areas should also include removal of all trees, brush, debris, and any other deleterious materials. These unsuitable materials should be properly disposed of off-site. Additionally, all organic topsoil within the proposed building areas, road areas, or areas to receive structural fill should be removed and the remaining roots grubbed. Areas where loose surficial soils exist due to grubbing operations should be considered as fill to the depth of disturbance and treated as subsequently recommended for structural fill placement. Any existing fill soils below footing areas should be stripped down to the underlying, medium dense to very dense natural till sediments. These sediments were encountered in our explorations at depths of approximately 1.5 to 3 feet.

8.2 Proof-Rolling

After stripping of the organic topsoil layer and removal of roots, we recommend that the soil exposed in proposed roadway areas be recompacted to a firm and unyielding condition using a 20-ton (minimum) vibratory roller. The recompacted area should then be proof-rolled with a fully loaded tandem-axle dump truck. Any soft or yielding areas identified during proof-rolling should be overexcavated and backfilled with structural fill.

8.3 Temporary and Permanent Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction based on the local conditions encountered at that time. For planning purposes, we anticipate that temporary, unsupported cut slopes in the loose to medium dense weathered native soils can be made at a maximum slope of 1H:1V (Horizontal:Vertical). Temporary cut slopes within the dense to very dense, unweathered till sediments can be planned for vertical up to 4 feet high, then at a 1H:1V inclination above the vertical cut. Flatter inclinations may be recommended in areas of seepage. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

Permanent cut or fill slopes should not exceed an inclination of 2H:1V.

8.4 Site Disturbance

The site soils contain a high percentage of fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill. If crushed rock is considered for the access and staging areas, it should be underlain by stabilization fabric (such as Mirafi 500X or approved equivalent) to reduce the potential of fine-grained materials pumping up through the rock and turning the area to mud. The fabric will also aid in supporting construction equipment, thus reducing the amount of crushed rock required. We recommend that at least 10 inches of rock be placed over the fabric; however, due to the variable nature of the near-surface soils and differences in wheel loads, this thickness may have to be adjusted by the contractor in the field. Crushed rock used for access and staging areas should be of at least 2-inch size.

9.0 STRUCTURAL FILL

Placement of structural fill may be necessary to establish desired grades in some areas. All references to structural fill in this report refer to subgrade preparation, fill type, and placement and compaction of materials as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

9.1 Subgrade Compaction

After overexcavation/stripping has been performed to the satisfaction of the geotechnical engineer/engineering geologist, the upper 12 inches of exposed ground should be

recompacted to a firm and unyielding condition. If the subgrade contains too much moisture, suitable recompaction may be difficult or impossible to attain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below. After the recompacted, exposed ground is tested and approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades.

9.2 Structural Fill Compaction

Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to at least 95 percent of the modified Proctor maximum dry density using *American Society for Testing and Materials* (ASTM):D 1557 as the standard. Roadway and utility trench backfill should be placed and compacted in accordance with applicable municipal codes and standards. The top of the compacted fill should extend horizontally a minimum distance of 3 feet beyond footings or pavement edges before sloping down at an angle no steeper than 2H:1V. Fill slopes should either be overbuilt and trimmed back to final grade or surface-compacted to the specified density.

9.3 Moisture-Sensitive Fill

Soils in which the amount of fine-grained material (smaller than No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather conditions. The on-site, natural glacial sediments are suitable for use as structural fill; however, they contain significant amounts of silt and are considered highly moisture-sensitive. At the time of our exploration, portions of the till sediments encountered in our exploration pits exhibited moisture contents in excess of the optimum for achieving maximum compaction. These soils are described on the attached exploration logs as "very moist" or "wet." These soils would require moisture-conditioning prior to their use as structural fill. Such moisture-conditioning could consist of spreading out and aerating the soil during periods of warm, dry weather.

Construction equipment traversing the site when the soils are very moist or wet can cause considerable disturbance. If fill is placed during wet weather or if proper compaction cannot be attained, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction.

9.4 Structural Fill Testing

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material at least 3 business days in advance to perform a Proctor test and determine its field compaction standard. A representative from our firm should observe the stripped subgrade and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid the owner in developing a suitable monitoring and testing frequency.

10.0 FOUNDATIONS

10.1 Allowable Soil Bearing Pressure

Spread footings may be used for building support when founded either directly on the medium dense to very dense, natural glacial sediments, or on structural fill placed over these materials. For footings founded either directly upon the medium dense to very dense glacial sediments, or on structural fill as described above, we recommend that an allowable bearing pressure of 2,000 pounds per square foot (psf) be used for design purposes, including both dead and live loads. For foundations founded totally upon dense to very dense unweathered till, a recommended allowable soil bearing pressure of 4,000 psf may be used. We recommend that the footing subgrade be recompacted to a firm and unyielding condition prior to footing placement. An increase in the allowable bearing pressure of one-third may be used for short-term wind or seismic loading. If structural fill is placed below footing areas, the structural fill should extend horizontally beyond the footing edges a distance equal to or greater than the thickness of the fill.

10.2 Footing Depths

Perimeter footings for the proposed buildings should be buried a minimum of 18 inches into the surrounding soil for frost protection. No minimum burial depth is required for interior footings; however, all footings must penetrate to the prescribed stratum, and no footings should be founded in or above loose, organic, or existing fill soils.

10.3 Footings Adjacent to Cuts

The area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of ASTM:D 1557. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus footings should not be placed near the edges of steps or cuts in the bearing soils.

10.4 Footing Settlement

Anticipated settlement of footings founded as described above should be on the order of 1 inch or less. However, disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements.

10.5 Footing Subgrade Bearing Verification

All footing areas should be observed by AESI prior to placing concrete to verify that the exposed soils can support the design foundation bearing capacity and that construction conforms with the recommendations in this report. Foundation bearing verification may also be required by the governing municipality.

10.6 Foundation Drainage

Perimeter footing drains should be provided as discussed under the "Drainage Considerations" section of this report.

11.0 LATERAL WALL PRESSURES

All backfill behind walls or around foundations should be placed following our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls, which are free to yield laterally at least 0.1 percent of their height, may be designed using an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 55 pcf. Walls that retain sloping backfill at a maximum angle of 50 percent should be designed for 45 pcf for yielding conditions and 65 pcf for restrained conditions. If parking areas or driveways are adjacent to walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces.

11.1 Wall Backfill

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of either the on-site glacial sediments or imported sand and gravel compacted to 90 to 95 percent of ASTM:D 1557. A higher degree of compaction is not recommended, as this will increase the pressure acting on the walls. A lower compaction may result in unacceptable settlement behind the walls. Thus, the compaction level is critical and must be tested by our firm during placement. The recommended compaction of 90 to 95 percent of ASTM:D 1557 applies to any structural fill placed behind the wall within a distance equal to the wall height and up to the elevation of the top of the wall. Structural fill used to construct slopes above retaining walls should be compacted to at least 95 percent of ASTM:D 1557 if the fill is placed above the elevation of the top of the wall. Surcharges from adjacent footings, heavy construction equipment, or sloping ground must be added to the above-recommended lateral pressures. Footing drains should be provided for all retaining walls, as discussed under the "Drainage Considerations" section of this report.

11.2 Wall Drainage

It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. This would involve installation of a minimum 1-foot-wide blanket drain for the full wall height using imported, washed gravel against the walls. If drainage mat is used, it should be installed according to the manufacturer's specifications.

11.3 Passive Resistance and Friction Factor

Lateral loads can be resisted by friction between the foundation and the natural, medium dense to dense glacial sediments or supporting structural fill soils, or by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with compacted structural fill to achieve the passive resistance provided below. We recommend the following design parameters:

- Passive equivalent fluid = 250 pcf
- Coefficient of friction = 0.30

The above values are allowable.

11.4 Seismic Surcharge

As required by the 2012 IBC, retaining wall design should include a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. We recommend a seismic surcharge pressure of 11H to 15H where H is the wall height in feet for the "active" and

“at-rest” loading conditions, respectively. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the wall.

12.0 FLOOR SUPPORT

Slab-on-grade floors may be constructed either directly on the medium dense to very dense natural sediments, or on structural fill placed over these materials. Areas of the slab subgrade that are disturbed (loosened) during construction should be recompacted to an unyielding condition prior to placing the capillary break, as described below.

If moisture intrusion through slab-on-grade floors is to be limited, the floors should be constructed atop a capillary break consisting of a minimum thickness of 4 inches of washed pea gravel, washed crushed rock, or other suitable material approved by the geotechnical engineer. The capillary break should be overlain by a 10-mil (minimum thickness) plastic vapor retarder.

13.0 DRAINAGE CONSIDERATIONS

The natural glacial sediments encountered in our explorations generally contained significant amounts of silt and are considered to be highly moisture-sensitive. Traffic from vehicles, construction equipment, and even foot traffic across these sediments when they are very moist or wet will result in disturbance of the otherwise firm stratum. Therefore, prior to site work and construction, the contractor should be prepared to provide drainage and subgrade protection, as necessary.

13.1 Wall/Foundation Drains

All retaining and perimeter footing walls should be provided with a drain at the footing elevation. The drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed pea gravel. The level of the perforations in the pipe should be set approximately 2 inches below the bottom of the footing, and the drains should be constructed with sufficient gradient to allow gravity discharge away from the buildings. All retaining walls should be lined with a minimum, 12-inch-thick, washed gravel blanket provided to within 1 foot of finish grade, and which ties into the footing drain. If drainage mat is used, it should be installed according to the manufacturer’s specifications. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain.

Exterior grades adjacent to walls should be sloped downward away from the structures to achieve surface drainage. Final exterior grades should promote free and positive drainage

away from the buildings at all times. Water must not be allowed to pond or to collect adjacent to the foundation or within the immediate building area. It is recommended that a gradient of at least 3 percent for a minimum distance of 10 feet from the building perimeter be provided, except in paved locations. In paved locations, a minimum gradient of 1 percent should be provided unless provisions are included for collection and disposal of surface water adjacent to the structures. Additionally, pavement subgrades should be crowned to provide drainage toward catch basins and pavement edges.

14.0 ROCKERIES

Rockerries may be used to prevent erosion of cut slopes; however, they are not engineered structures and should not be used in place of retaining walls. Rockerries may also be used to prevent erosion of fill slopes when the fill is reinforced with geogrid. Rockerries greater than 4 feet high should not be used in fill sections unless the fill is reinforced following an engineered geogrid design. Buildings should be set back from rockeries so that a 1H:1V line extending up from the rear base of the rockery does not intersect the footing. Rockery quality depends largely on the skill of the builder and the quality of the rock. AESI does not recommend rockeries be constructed greater than 12 feet high. Recommended details for the construction of rockeries fronting cuts in native soils and fronting fill soils are presented on Figures 3 and 4.

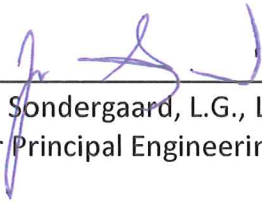
15.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We are available to provide additional geotechnical consultation as the project design develops and possibly changes from that upon which this report is based. If significant changes in grading are made, we recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, our earthwork and foundation recommendations may be properly interpreted and implemented in the design. This plan review is not included in our current scope of work and budget.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the foundations depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of this current scope of work. If these services are desired, please let us know, and we will prepare a proposal.

We have enjoyed working with you on this study and are confident that these recommendations will aid in the successful completion of your project. If you should have any questions, or require further assistance, please do not hesitate to call.

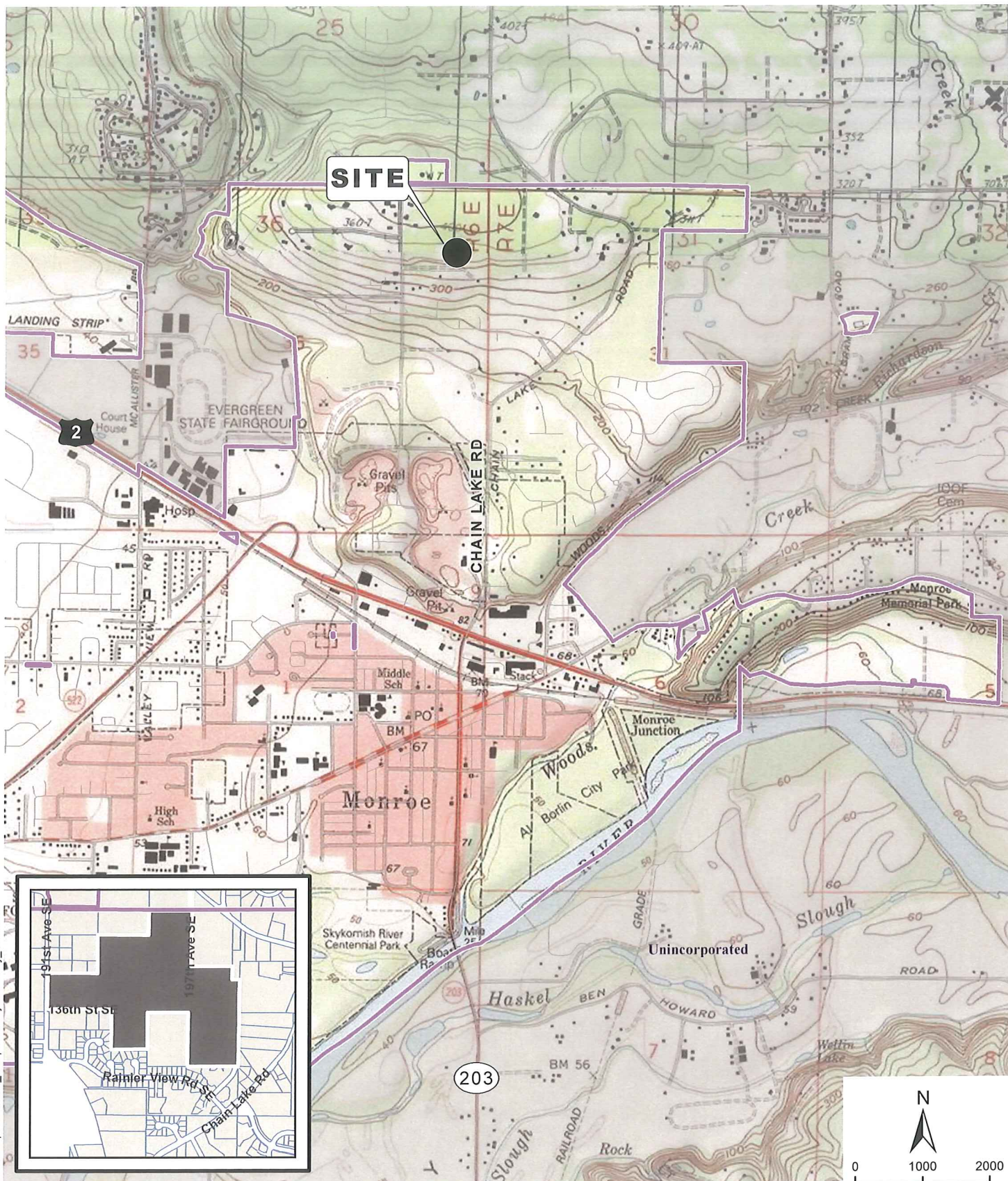
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington



Jon N. Sondergaard, L.G., L.E.G.
Senior Principal Engineering Geologist

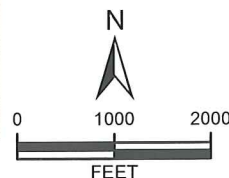
Matthew A. Miller, P.E.
Principal Engineer

Attachments: Figure 1: Vicinity Map
Figure 2: Site and Exploration Plan
Figure 3: Unreinforced Rockery Detail
Figure 4: Geogrid Reinforced Rockery Detail
Appendix: Exploration Logs



REFERENCE: USGS, SNOHOMISH CO

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

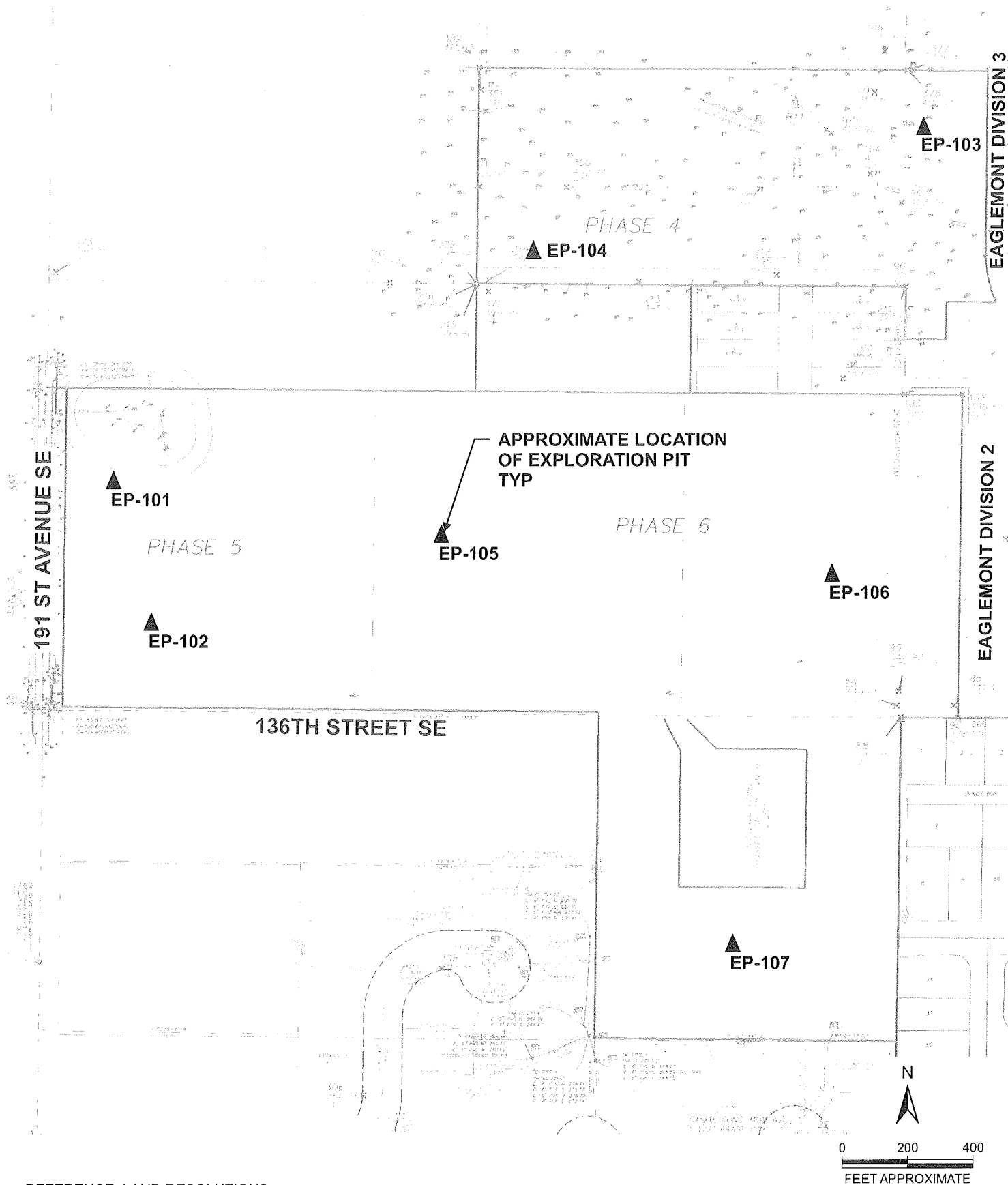


VICINITY MAP EAGLEMONT - PHASES 4, 5 AND 6 MONROE, WASHINGTON

FIGURE 1

DATE 12/14

PROJ. NO. KE120280A



REFERENCE: LAND RESOLUTIONS



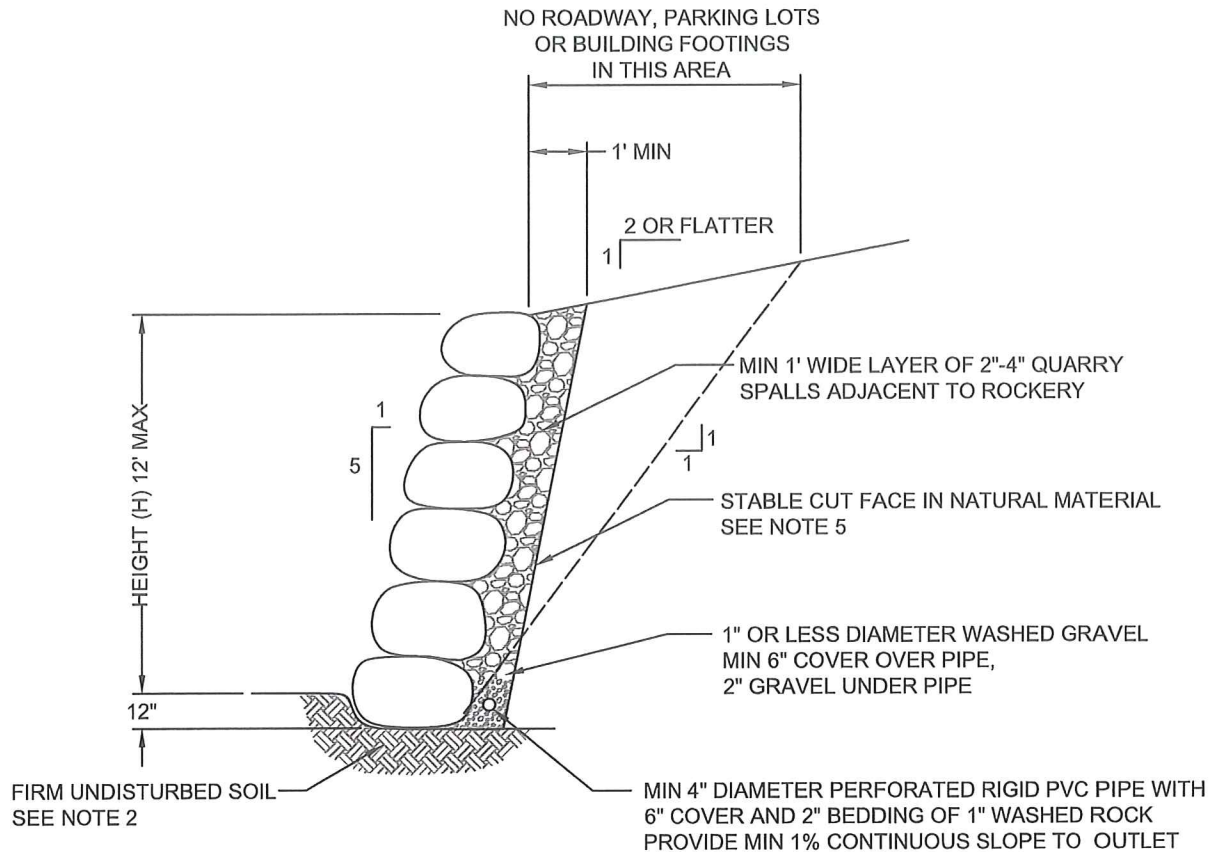
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SITE AND EXPLORATION PLAN
EAGLEMONT PHASES 4,5 AND 6
MONROE, WASHINGTON

FIGURE 2

DATE 12/14

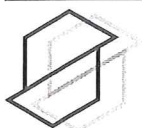
PROJ. NO. KE120280A



NOTES:

1. ROCKERIES HIGHER THAN 5' SHALL BE CONSTRUCTED OF ROCKS OF GRADUATED SIZES FROM 5-MAN TO 2-MAN, FROM BOTTOM TO TOP. ROCKERIES OF 5' OR LOWER SHALL BE CONSTRUCTED OF 3-MAN TO 2-MAN, FROM BOTTOM TO TOP.
2. INSPECTION OF SUBGRADE, PLACEMENT OF BASE COURSE AND DRAINAGE, AND FINISHED ROCKERY BY ENGINEER IS REQUIRED.
3. ROCK SHALL BE SOUND AND HAVE A MINIMUM DENSITY OF 160 POUNDS PER CUBIC FOOT.
4. THE LONG DIMENSION OF ALL ROCKS SHALL BE PLACED PERPENDICULAR TO THE WALL. EACH ROCK SHOULD BEAR ON TWO ROCKS IN THE TIER BELOW.
5. ROCKERIES ARE EROSION-CONTROL STRUCTURES, NOT RETAINING WALLS. NATURAL MATERIAL MUST BE STABLE AND FREE STANDING IN CUT FACE. MAXIMUM HEIGHT OF 3 FEET FOR ROCKERIES FACING UNREINFORCED FILL SOILS.
6. SEE TEXT OF REPORT FOR ADDITIONAL RECOMMENDATIONS.

ROCK	LB.	AVG. DIMENSION (IN.)
1-MAN	50-200	12 TO 18
2-MAN	200-700	18 TO 28
3-MAN	700-2000	28 TO 36
4-MAN	2000-4000	36 TO 48
5-MAN	4000-6000	48 TO 54



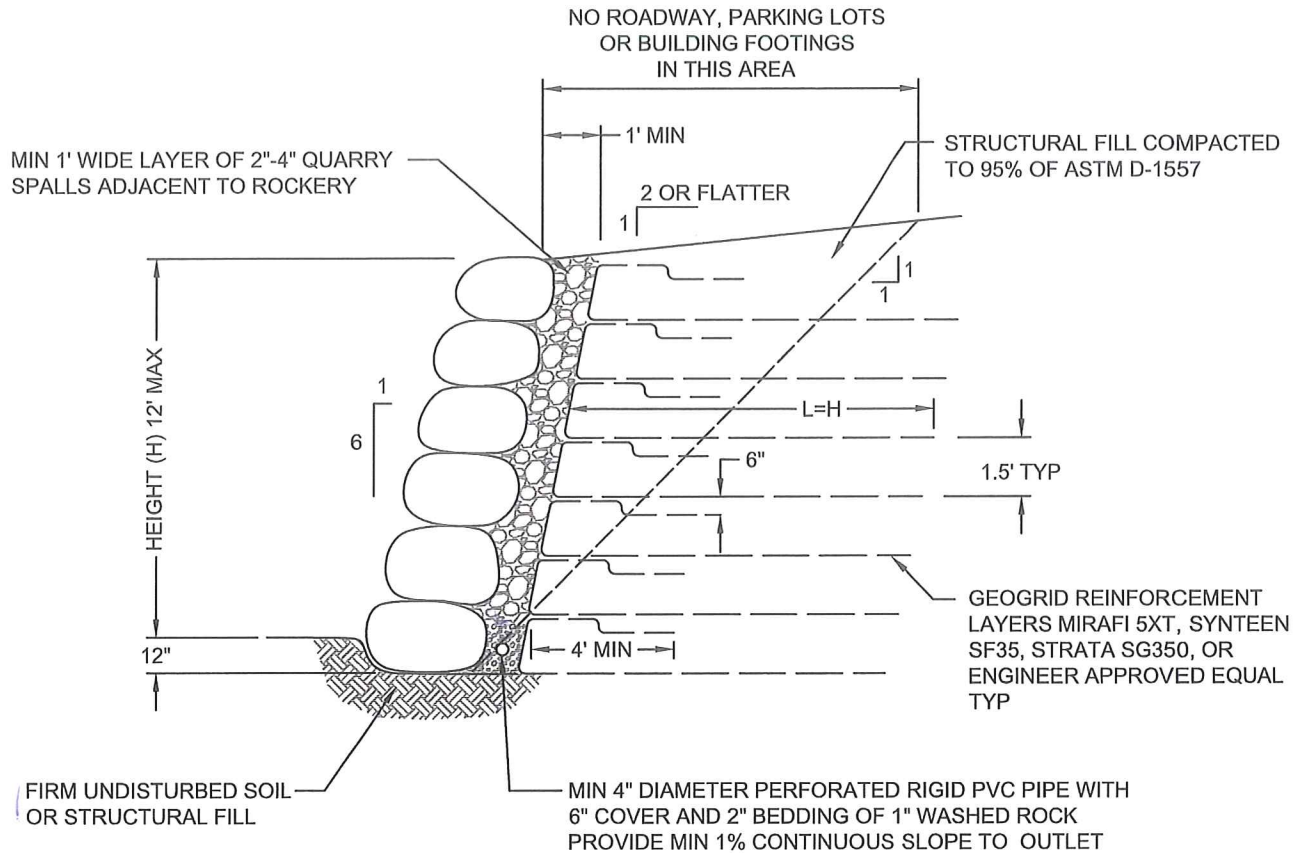
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UNREINFORCED ROCKERY DETAIL
EAGLEMONT - PHASES 4,5 AND 6
MONROE, WASHINGTON

FIGURE 3

DATE 12/14

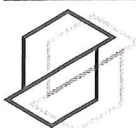
PROJECT NO. KE120280A



NOTES:

1. ROCKERIES HIGHER THAN 5' SHALL BE CONSTRUCTED OF ROCKS OF GRADUATED SIZES FROM 5-MAN TO 2-MAN, FROM BOTTOM TO TOP. ROCKERIES OF 5' OR LOWER SHALL BE CONSTRUCTED OF 3-MAN TO 2-MAN, FROM BOTTOM TO TOP.
2. INSPECTION OF SUBGRADE SOILS, GEOGRID PLACEMENT, COMPACTION OF STRUCTURAL FILL, ROCK PLACEMENT AND DRAINAGE BY GEOTECHNICAL ENGINEER IS REQUIRED.
3. ROCK SHALL BE SOUND AND HAVE A MINIMUM DENSITY OF 160 POUNDS PER CUBIC FOOT.
4. THE LONG DIMENSION OF ALL ROCKS SHALL BE PLACED PERPENDICULAR TO THE WALL. EACH ROCK SHOULD BEAR ON TWO ROCKS IN THE TIER BELOW.
5. MAXIMUM HEIGHT OF 3 FEET FOR ROCKERIES FACING UNREINFORCED FILL SOILS.
6. SEE TEXT OF REPORT FOR ADDITIONAL RECOMMENDATIONS.

ROCK	LB.	AVG. DIMENSION (IN.)
1-MAN	50-200	12 TO 18
2-MAN	200-700	18 TO 28
3-MAN	700-2000	28 TO 36
4-MAN	2000-4000	36 TO 48
5-MAN	4000-6000	48 TO 54



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GEOGRID REINFORCED ROCKERY DETAIL
EAGLEMONT - PHASES 4,5 AND 6
MONROE, WASHINGTON

FIGURE 4

DATE 12/14

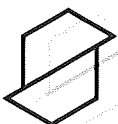
PROJECT NO. KE120280A

APPENDIX

Exploration Logs

Coarse-Grained Soils - More than 50% ⁽¹⁾ Retained on No. 200 Sieve			Terms Describing Relative Density and Consistency	
Gravels - More than 50% ⁽¹⁾ of Coarse Fraction Retained on No. 4 Sieve	Sands - 50% ⁽¹⁾ or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines ⁽⁵⁾	≥12% Fines ⁽⁵⁾	
		GW	GP	GM

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.



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EXPLORATION LOG KEY

FIGURE A1

LOG OF EXPLORATION PIT NO. EP-101

Depth (ft)	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p>DESCRIPTION</p>	
1	<p>Topsoil Loose, moist to very moist, dark brown, silty SAND, few gravel, few organics.</p>	
2	<p>Weathered Vashon Lodgement Till Loose to medium dense, moist to very moist, reddish brown, silty SAND, with gravel, trace to few subrounded cobbles (SM).</p>	
3	<p>Vashon Lodgement Till Dense to very dense, moist, brownish gray, silty SAND, with gravel, few subrounded cobbles (SM).</p>	
4		
5		
6	Bottom of exploration pit at depth 5 feet No seepage. No caving.	
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Approved by:



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LOG OF EXPLORATION PIT NO. EP-102

Depth (ft)	DESCRIPTION
	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p>
	Topsoil
1	Loose, moist, dark brown, silty SAND, few gravel, few organics.
	Fill
2	Medium dense, moist, brownish gray, silty SAND, little gravel (SM).
	Weathered Vashon Lodgement Till
3	Loose to medium dense, moist to very moist, tan brown, silty SAND, with gravel, trace subrounded cobbles (SM).
	Vashon Lodgement Till
4	Dense to very dense, moist, brownish gray, silty SAND, with gravel, trace to few subrounded cobbles (SM).
5	
6	
7	Bottom of exploration pit at depth 6 feet Slight seepage at 3.5 feet. No caving.
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LOG OF EXPLORATION PIT NO. EP-103

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	DESCRIPTION
1	Topsoil Loose, moist to very moist, dark brown, silty SAND, few gravel, few organics.
2	Weathered Vashon Lodgement Till Loose to medium dense, moist to very moist, reddish brown, silty SAND, with gravel, trace to few subrounded cobbles (SM).
3	Vashon Lodgement Till Dense to very dense, moist, brownish gray, silty SAND, with gravel, few subrounded cobbles (SM).
4	
5	
6	Bottom of exploration pit at depth 5 feet Moderate seepage at 3 feet. No caving.
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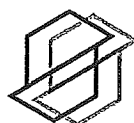
LOG OF EXPLORATION PIT NO. EP-104

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	DESCRIPTION
	Topsoil
1	Loose, moist, dark brown, silty SAND, few gravel, few organics.
2	Weathered Vashon Lodgement Till
2	Loose to medium dense, moist to very moist, reddish brown, silty SAND, with gravel, trace to few subrounded cobbles (SM).
3	Vashon Lodgement Till
4	Dense to very dense, moist, brownish gray, silty SAND, with gravel, trace to few subrounded cobbles (SM).
5	Bottom of exploration pit at depth 4.5 feet Moderate seepage at 2.5 feet. No caving.
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Project No. KE120280A

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LOG OF EXPLORATION PIT NO. EP-105

Depth (ft)	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p>DESCRIPTION</p>	
1	<p>Topsoil Loose, moist, dark brown, silty SAND, few gravel, few organics.</p>	
2	<p>Weathered Vashon Lodgement Till Loose to medium dense, moist to very moist, reddish brown, silty SAND, with gravel, trace to few subrounded cobbles (SM).</p>	
3	<p>Vashon Lodgement Till Dense to very dense, moist, brownish gray, silty SAND, with gravel, trace to few subrounded cobbles (SM).</p>	
4		
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6	<p>Bottom of exploration pit at depth 5.5 feet Slight to moderate seepage at 3 feet. No caving.</p>	
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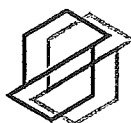
LOG OF EXPLORATION PIT NO. EP-106

Depth (ft)	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p>DESCRIPTION</p>	
1	<p>Topsoil Loose, moist to very moist, dark brown, silty SAND, few gravel, few organics.</p>	
2	<p>Weathered Vashon Lodgement Till Loose to medium dense, moist to very moist, reddish brown, silty SAND, with gravel, trace to few subrounded cobbles (SM).</p>	
3	<p>Vashon Lodgement Till Dense to very dense, moist, brownish gray, silty SAND, with gravel, few subrounded cobbles (SM).</p>	
4		
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6	<p>Bottom of exploration pit at depth 5 feet Slight seepage at 3 feet. No caving.</p>	
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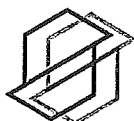
Project No. KE120280A

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LOG OF EXPLORATION PIT NO. EP-107

Depth (ft)	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p>DESCRIPTION</p>	
1	<p>Topsoil</p> <p>Loose, moist, dark brown, silty SAND, few gravel, few organics.</p>	
2	<p>Weathered Vashon Lodgement Till</p> <p>Loose to medium dense, moist to very moist, reddish brown, silty SAND, with gravel, trace to few subrounded cobbles (SM).</p>	
3	<p>Vashon Lodgement Till</p> <p>Dense to very dense, moist, brownish gray, silty SAND, with gravel, trace to few subrounded cobbles (SM).</p>	
4		
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11	<p>Bottom of exploration pit at depth 10 feet</p> <p>Slight seepage at 3 feet. No caving.</p>	
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